Claims

1. A tuner as constituent component for constructing a tunable or switchable spectral filter, including single and multiple stage filters and filters without intermediate polarizer, over a wavelength range is characterized in that said tuner comprises elements arranged in cascade along a light beam axis including

a dispersive polarization rotator (31), having its rotation angle $\rho(\lambda)$ varying as a function of light wavelength λ over said wavelength range;

an orientation-sensitive polarizing element, and

means for rotating said polarizing element and/or varying said rotation angle $\rho(\lambda)$;

and characterized in that said polarization rotator and said polarizing element are arranged in series in said spectral filter along said light beam axis with said polarizing element oriented at a predetermined orientation angle related to the structure of said spectral filter, and said tuner is operated by rotating said polarizing element to change its orientation in said filter and/or by changing said rotation angle $\rho(\lambda)$. [Ex. FIGS. 6a-c]

2. The tuner of claim 1 is characterized in that said polarization rotator preferably is a dispersive optical rotator, typically a quartz optical rotator, or a dispersive Faraday rotator, to which magnetic field is applied, having the rotation angle changeable by adjusting the magnetic flux density of said magnetic field and said polarizing element preferably is a polarizer, typically a dichroic or birefringent polarizer, or an optical retarder selected preferably from achromatic or zero-order birefringent retarders, equivalent liquid crystal electrically rotatable retarders, including FLC cells, SmA* cells, DHF liquid crystal cells, SSFLC cells, planar aligned smectic C* cells and ternary state antiferroelectric-effect LC cells, and variable retarders, including liquid crystal variable retarders such as nematic or homeotropically aligned smectic LC cells and phase modulators such as electro-optical, photo-elastic and magnetic modulators.

3. The tuner of claim 1 is characterized in that said polarizing element is a polarizer (32), used as the exit or entrance polarizer of said filter and having its azimuth P relative to the reference axis of said filter, said polarization rotator (31) and said polarizer (32) are arranged in said spectral filter along said light beam axis with said polarization rotator followed or preceded by said polarizer, and said tuner is a polarizer-tuner (33), which is equivalent to a polarizer having the azimuth equal to $P+\rho(\lambda)$ or $P-\rho(\lambda)$ varying as a function of light wavelength λ over said wavelength range, and is operated by changing said azimuth P and/or said rotation angle $\rho(\lambda)$ to change said azimuth $P+\rho(\lambda)$ or $P-\rho(\lambda)$ of said polarizer-tuner. [Ex. FIG. 6a]

4. The tuner of claim 1 is characterized in that said polarizing element is a retarder (34), having its retardation Δ equal or approximately equal to a predetermined value related to the structure of said spectral filter over said wavelength range, said polarization rotator (31) and retarder (34) are arranged in said spectral filter along said light beam axis with said retarder having its optic axis oriented at a predetermined angle φ related to the structure of said spectral filter in said filter, and said tuner is equivalent to a series connection of an equivalent optical rotator (36) of rotation angle $\rho(\lambda)$ and a retarder-tuner (35), which is equivalent to a

retarder having its retardation equal to Δ and the orientation angle of its optic axis equal to $\varphi+\rho(\lambda)$ or $\varphi-\rho(\lambda)$ over said wavelength range, and operated by changing said orientation angle φ and/or said rotation angle $\rho(\lambda)$ to change said orientation angle $\varphi+\rho(\lambda)$ or $\varphi-\rho(\lambda)$ of said retarder-tuner and/or by changing said retardation Δ. [Ex. FIG. 6b]

5. The tuner of claim **4** is characterized in that said tuner further comprises a second dispersive polarization rotator (37) having its rotation angle $-\rho(\lambda)$ varying as a function of light wavelength λ over said wavelength range, positioned on the opposite side of said retarder (34) from said rotator (31) of rotation angle $\rho(\lambda)$, said tuner is a retarder-tuner (35) equivalent to a retarder having its retardation equal to Δ and the orientation angle of its optic axis equal to $\varphi+\rho(\lambda)$ or $\varphi-\rho(\lambda)$ over said wavelength range, operated by changing said orientation angle φ and/or by simultaneously changing said rotation angles $\rho(\lambda)$ and $-\rho(\lambda)$ to change said orientation angle $\varphi+\rho(\lambda)$ or $\varphi-\rho(\lambda)$ of said retarder-tuner and/or by changing said retardation Δ. [Ex. FIG. 6c]

6. A spectral filter over a wavelength range is characterized in that said filter comprises elements arranged in cascade along a light beam axis according to claims **3**, **4** and **5** including

an entrance polarizer;

at least a dispersive polarization rotator with the rotation angle varying as a function of light wavelength over said wavelength range;

at least an orientation-sensitive polarizing element; and

means for rotating said orientation-sensitive polarizing element(s) about said light beam axis and/or varying said rotation angle(s);

and characterized in that said polarizing element or at least one of said polarizing elements is a polarizer, said polarization rotator(s) and polarizing element(s) are arranged behind said entrance polarizer along said beam axis to form tuner(s) according to claims **3**, **4** and **5** such that said polarizing element that is a polarizer works as the exit polarizer of said filter, and said filter has its spectral transmission determined by said rotation angle(s) and tunable by rotating said exit polarizer and/or the other(s) of said polarizing element(s) about said beam axis and further tunable by varying said rotation angle(s). [Ex. FIGS. 7-11, 14, 16-18, 22, 24, 25, 29]

7. The spectral filter of claim **6** is characterized in that said polarization rotator(s) preferably is or are dispersive optical rotator(s), typically quartz optical rotator(s), or Faraday rotator(s), to which magnetic field is or are applied, having the rotation angle(s) changeable by adjusting the magnetic flux density or densities of said magnetic field(s) and said polarizing element(s) preferably is or are polarizer(s), typically dichroic or birefringent polarizer(s), or retarder(s) selected preferably from achromatic or zero-order birefringent retarders, equivalent liquid crystal electrically rotatable retarders, including FLC cells, SmA* cells, DHF liquid crystal cells, SSFLC cells, planar aligned smectic C* cells and ternary state antiferroelectric-effect LC cells, and variable retarders, including liquid crystal variable retarders such as nematic or homeotropically aligned smectic LC cells and phase modulators such as electro-optical, photo-elastic and magnetic modulators.

8. The spectral filter of claim **6** is characterized in that said filter is a single-stage spectral filter over said wavelength range comprising elements arranged in cascade along said light beam axis including

an entrance polarizer (40);

a dispersive polarization rotator (41) with the rotation angle varying as a function of light wavelength over said wavelength range, selected preferably from optical rotators and Faraday rotators;

an exit polarizer (42); and

means for rotating said exit polarizer about said light beam axis;

and characterized in that said polarization rotator (41) is sandwiched between said entrance and exit polarizers (40, 42) with the combination of said polarization rotator (41) and polarizer (42) equivalent to a polarizer-tuner according to claim **3** and said filter has its spectral transmission determined by said rotation angle and tunable by rotating said exit polarizer about said beam axis relative to said entrance polarizer and further tunable by varying said rotation angle. [Ex. FIGS. 7-10]

9. The single-stage filter of claim **8** is characterized in that said polarization rotator (41) preferably is a dispersive optical rotator, typically a quartz optical rotator, and the spectral transmission of said filter is tunable by rotating said exit polarizer (42) about said beam axis relative to said entrance polarizer (40). [Ex. FIG. 7]

10. The single-stage filter of claim **8** is characterized in that said polarization rotator preferably (41) is a dispersive Faraday rotator, to which a magnetic field is applied, having the rotation angle changeable by adjusting the magnetic flux density of said magnetic field, and said filter further comprises means for changing the rotation angle of said Faraday rotator by adjusting the magnetic flux density of said magnetic field. [Ex. FIG. 7]

11. The single-stage filter of claim **10** is characterized in that said filter has its spectral transmission determined by said Faraday rotation angle and tunable by varying said Faraday rotation angle or switchable by switching said Faraday rotation angle in at least two alternative states, further tunable by rotating said exit polarizer (42) about said beam axis relative to said entrance polarizer (40), and functions as a one-direction device that transmits and tunably filters light in one direction, but blocks the backward light, with said exit polarizer preferably fixed and oriented at 45° relative to said entrance polarizer. [Ex. FIG. 7]

12. The single-stage filter of claim **8** is characterized in that said polarization rotator preferably is a dispersive optical rotator (43), typically a quartz optical rotator, and said filter further comprises a rotatable half-wave retarder (44) having its retardation equal or approximately equal to 180° over said wavelength range, preferably an equivalent achromatic or zero-order birefringent retarder or liquid crystal electrically rotatable retarder, positioned immediately behind or before said optical rotator (43). [Ex. FIG. 8]

13. The single-stage filter of claim **12** is characterized in that the combination of said optical rotator (43) and retarder (44) is equivalent to a tuner according to claim **4** and said filter has its spectral transmission

determined by said rotation angle of said optical rotator with and tunable by rotating said half-wave retarder about said light beam axis, mechanically and/or electrically, and further tunable by rotating said exit polarizer (42) relative to said entrance polarizer (40). [Ex. FIG. 8]

14. The single-stage filter of claim **8** is characterized in that said polarization rotator preferably is a dispersive optical rotator (43), typically a quartz optical rotator, said filter further comprises an active polarization rotator (45) having its rotation angle adjustable over said wavelength range, positioned immediately before or behind said passive optical rotator (43), and means for changing the rotation angle of said active polarization rotator. [Ex. FIG. 9]

15. The single-stage filter of claim **14** is characterized in that the combination of said optical rotator (43), active polarization rotator (45) and polarizer (42) is equivalent to a polarizer-tuner according to claim **2** and said filter has its spectral transmission tunable or switchable by changing said rotation angle of said active polarization rotator and further tunable by rotating said exit polarizer (42) relative to said entrance polarizer (42). [Ex. FIG. 9]

16. The single-stage filter of claim **15** is characterized in that said active polarization rotator (45) preferably is a Faraday rotator, to which a magnetic field is applied, having the rotation angle changeable by adjusting the magnetic flux density of said magnetic field, or a liquid crystal polarization rotator, having the rotation angle continuously or discretely rotatable by application of a control voltage, typically a twisted-nematic liquid crystal polarization rotator, positioned immediately before said passive polarization rotator (43) and oriented with its entrance crystal axis parallel to the transmission axis of said entrance polarizer (40). [Ex. FIG. 9]

17. The single-stage filter of claim **8** is characterized in that said exit polarizer (42) preferably is stationary and oriented parallel or perpendicular to said entrance polarizer (40) and said polarization rotator is a dispersive optical rotator (43), typically a quartz optical rotator, and said filter further comprises

a second dispersive optical rotator (47), selected such that said second optical rotator and said initial optical rotator build up a pair of optical rotators having equal and opposite rotation angles over said wavelength range,

a variable retarder (46) operated to work as a switchable retarder, having its retardation switchable between two alternative states such that said retarder has the retardation equal or approximately equal to zero in one of said states and 180° in the other, respectively, over said wavelength range, and

means for operating said retarder with said retardation switchable in said states and rotating said retarder about said beam axis. [Ex. FIG. 10]

18. The single-stage filter of claim **17** is characterized in that said second optical rotator (47) and variable retarder (46) are arranged in series between said entrance and exit polarizers (40, 42) and positioned with said variable retarder (46) facing said initial optical rotator (43) and said filter has its spectral transmission determined by said rotation angles, with the combination of said optical rotator (43), variable

retarder (46) and second optical rotator (47) equivalent to a retarder-tuner according to claim **5**, and switchable by switching said retarder between said switched states and further tunable by rotating said retarder about said beam axis relative to said entrance polarizer. [Ex. FIG. 10]

19. The spectral filter of claim **6** is characterized in that said filter is an n-stage (n=2, 3, 4, ...) spectral filter over said wavelength range comprising elements arranged in cascade along said light beam axis including

an entrance polarizer (49_1);

n–1 intermediate polarizers (49_2, 49_3, ..., 49_n);

n dispersive polarization rotators (50_1, 50_2, ..., 50_n), which have their wavelength-dependent rotation angles in the ratios of integers, preferably in the ratios of 1:2:4:8: ... :2^{n-1} disregarding the rotation sense over said wavelength range and are selected preferably from optical rotators and Faraday rotators;

an exit polarizer (49_{n+1}); and

means for rotating said exit polarizer and n–1 intermediate polarizers about said light beam axis;

and characterized in that said n–1 intermediate polarizers (49_2, 49_3, ..., 49_n) and n polarization rotators (50_1, 50_2, ..., 50_n) are arranged between said entrance and exit polarizers (49_1, 49_{n+1}); along said light beam axis to form n stages in series, each containing a polarization rotator between polarizers according to claim **8**, such that each of said intermediate polarizers (49_2, 49_3, ..., 49_n) serves as the exit polarizer of one stage and the entrance polarizer of the following adjacent stage and such that the formed n stage exit polarizers (49_2, 49_3, ..., 49_n , 49_{n+1}) are oriented, each relative to its immediately preceding polarizer, with their azimuths in the same ratios as those of the rotation angles of the n polarization rotators (50_1, 50_2, ..., 50_n), which are immediately preceding said n stage exit polarizers, and said filter has its spectral transmission determined by said rotation angles and tunable by simultaneously rotating said n stage exit polarizers about said light beam axis with said ratios of their azimuths remaining unchanged or such that said n stage exit polarizers are parallel or perpendicular to said entrance polarizer and further tunable by simultaneously varying said rotation angles of said n polarization rotators with said ratios of said rotation angles remaining unchanged. [Ex. FIGS. 11, 14, 16, 17]

20. The spectral filter of claim **19** is characterized in that said n polarization rotators (50_1, 50_2, ..., 50_n) preferably are dispersive optical rotators with their wavelength-dependent rotation angles in said ratios of integers over said wavelength range and the spectral transmission of said filter is tunable by simultaneously rotating said n stage exit polarizers (49_2, 49_3, ..., 49_{n+1}) about said beam axis with said ratios of their azimuths remaining unchanged or such that said n stage exit polarizers are parallel or perpendicular to said entrance polarizer. [Ex. FIG. 11]

21. The spectral filter of claim **19** is characterized in that said n polarization rotators (50_1, 50_2, ...,

50_n) preferably are dispersive Faraday rotators with their wavelength-dependent rotation angles in said ratios of integers over said wavelength range, to which magnetic fields are applied, respectively, and said filter further comprises means for changing said Faraday rotation angles by adjusting the magnetic flux densities of said magnetic fields. [Ex. FIG. 11]

22. The spectral filter of claim **21** is characterized in that said filter has its spectral transmission determined by said Faraday rotation angles and tunable by simultaneously varying said Faraday rotation angles or switchable by simultaneously switching said Faraday rotation angles in at least two alternative states such that said Faraday rotation angles have their said ratios remaining unchanged or said Faraday rotation angles are equal or approximately equal to zero over said wavelength range, further tunable by simultaneously rotating said n stage exit polarizers about said light beam axis with said ratios of their azimuths remaining unchanged or such that said n stage exit polarizers are parallel or perpendicular to said entrance filter, and functions as a one-direction device that transmits and tunably filters light in one direction, but blocks the backward light, with said n stage exit polarizers preferably stationary and oriented such that the stage exit polarizer, which immediately follows the Faraday rotator of the smallest rotation angle among said n Faraday rotation angles, is oriented preferably at 45° related to its immediately preceding polarizer and the rest n−1 stage exit polarizers are parallel or perpendicular to said entrance polarizer. [Ex. FIG. 11]

23. The spectral filter of claim **19** is characterized in that said n polarization rotators preferably are dispersive optical rotators (51_1, 51_2, ..., 51_n), typically quartz optical rotators, with their wavelength-dependent rotation angles in said ratios of integers over said wavelength range, said n stage exit polarizers (49_2, 49_3, ..., 49_{n+1}) are oriented preferably parallel or perpendicular to said entrance polarizer, and said spectral filter further comprises n rotatable half-wave retarders (52_1, 52_2, ..., 52_n), each having its retardation equal or approximately equal to 180° over said wavelength range, positioned respectively immediately behind or before said arranged n optical rotators (51_1, 51_2, ..., 51_n) such that each of said stages is in accordance with claim **12** and oriented such that said n half-wave retarders are parallel to their immediately preceding polarizers, respectively, or have their orientation angles, each relative to its immediately preceding polarizer, in the same ratios as those of said rotation angles of said arranged n optical rotators. [Ex. FIG. 14]

24. The spectral filter of claim **23** is characterized in that said n retarders (52_1, 52_2, ..., 52_n) preferably are achromatic or zero-order birefringent retarders or equivalent liquid crystal electrically rotatable retarders oriented, each relative to its immediately preceding polarizer, such that their orientation angles in the same ratios as those of the rotation angles of said arranged n optical rotators (51_1, 51_2, ..., 51_n) and the spectral transmission of said filter is determined by said rotation angles of said optical rotators and tunable by simultaneously rotating said n birefringent retarders or liquid crystal retarders about said light beam axis, mechanically and/or electrically, with said ratios of their said orientation angles remaining unchanged or such that said orientation angles are equal to zero and can further be tunable by simultaneously rotating said n stage exit polarizers with their azimuths, each relative to its immediately preceding polarizer, in said ratios of their immediately preceding optical rotation angles. [Ex. FIG. 14]

25. The spectral filter of claim **19** is characterized in that said n polarization rotators preferably are dispersive optical rotators (51_1, 51_2, ..., 51_n), typically quartz optical rotators, having their wavelength-dependent rotation angles in said ratios of integers over said wavelength range, said n stage exit polarizers (49_2, 49_3, ..., 49_{n+1}) preferably are stationary and oriented parallel or perpendicular to said entrance polarizer, and said filter further comprises n active polarization rotators (53_1, 53_2, ..., 53_n), which have their rotation angles adjustable over said wavelength and are positioned immediately before or behind said n passive optical rotators (51_1, 51_2, ..., 51_n), respectively, such that each of said stages is in accordance with claim **14** and the rotation angles of said arranged n active polarization rotators (53_1, 53_2, ..., 53_n) are in the same ratios as those of their immediately following or preceding n optical rotators over said wavelength range, and means for changing the rotation angles of said n active polarization rotators, and said filter has its spectral transmission tunable or switchable by simultaneously changing said active rotation angles with said ratios of said active rotation angles remaining unchanged or equal or approximately equal to zero over said wavelength range and further tunable by simultaneously rotating said n stage exit polarizers (49_2, 49_3, ..., 49_{n+1}) with their azimuths, each relative to its immediately preceding polarizer, in said ratios of their immediately preceding optical rotation angles. [Ex. FIG. 16]

26. The spectral filter of claim **25** is characterized in that said n active polarization rotators (53_1, 53_2, ..., 53_n), preferably are Faraday rotators, to which magnetic fields are respectively applied, having the rotation angles changeable by adjusting the magnetic flux densities of said magnetic fields, or equivalent liquid crystal polarization rotators, having their rotation angles continuously or discretely adjustable, positioned immediately before or behind said n optical rotators (51_1, 51_2, ..., 51_n), respectively, such that said arranged n Faraday rotators or liquid crystal rotators have their rotation angles in the same ratios as those of their immediately following or preceding n optical rotators or equal or approximately equal to zero when being switched on or off over said wavelength range, and the spectral transmission of said filter is tunable or switchable by simultaneously adjusting said rotation angles of said Faraday rotators or liquid crystal rotators with said ratios of said rotation angles remaining unchanged or equal or approximately equal to zero over said wavelength range. [Ex. FIG. 16]

27. The spectral filter of claim **26** is characterized in that said n liquid crystal polarization rotators (53_1, 53_2, ..., 53_n) preferably are twisted-nematic liquid crystal polarization rotators, positioned respectively immediately before said n optical rotators (51_1, 51_2, ..., 51_n) and oriented with the entrance crystal axis of each of said twisted-nematic rotators parallel to the transmission axis of its immediately preceding polarizer, said twisted-nematic rotators have their rotation angles equal or approximately equal to zero or in the same ratios as those of their immediately following n optical rotators over said wavelength range when said twisted-nematic rotators are switched on and off, respectively, and the spectral transmission of said filter is switchable by simultaneously switching said twisted-nematic liquid crystal polarization rotators on and off. [Ex. FIG. 16]

28. The spectral filter of claim **19** is characterized in that said formed n stage exit polarizers (49_2,

49_3, ..., 49_{n+1}) preferably are stationary and oriented parallel or perpendicular to said entrance polarizer (49_1), said n polarization rotators preferably are dispersive optical rotators (51_1, 51_2, ..., 51_n), typically quartz optical rotators, having their wavelength-dependent rotation angles in said ratios of integers over said wavelength range, and said filter further comprises

another n dispersive optical rotators (54_1, 54_2, ..., 54_n), selected such that said another n optical rotators (54_1, 54_2, ..., 54_n), and said initial n optical rotators (51_1, 51_2, ..., 51_n) build up n pairs of optical rotators, each having equal and opposite rotation angles over said wavelength range, and positioned such that each of said n stages contains a pair of optical rotators having equal and opposite rotation angles,

n identical variable retarders (55_1, 55_2, ..., 55_n), operated to work as switchable retarders, each having its retardation switchable between two alternative states such that its retardation is equal or approximately equal to zero in one of said states and 180° in the other, respectively, over said wavelength range, and positioned such that each of said n stages contains one of said retarders, sandwiched between the optical rotators of this stage, in accordance with claim **17** and

means for switching said n retarders and rotating said n retarders about said beam axis. [Ex. FIG. 17]

29. The spectral filter of claim **28** is characterized in that said positioned n variable retarders (55_1, 55_2, ..., 55_n) are oriented parallel to said entrance polarizer or with their orientation angles, each relative to its immediately preceding polarizer, in the same ratios as those of the rotation angles of their immediately preceding optical rotators, and said filter has its spectral transmission determined by said rotation angles and switchable by simultaneously switching said n retarders (55_1, 55_2, ..., 55_n) in said switched states and further tunable by simultaneously rotating said n retarders about said beam axis with said ratios of said orientation angles remaining unchanged or such that each of said n retarders is parallel or perpendicular to its immediately preceding polarizer. [Ex. FIG. 17]

30. The spectral filter of claim **6** is characterized in that said filter is a two-tuner spectral filter without intermediate polarizer according to claim **5** over said wavelength range comprising elements arranged in cascade along said light beam axis including

an entrance polarizer (61);

a first polarization rotator (62), having its rotation angle $\rho_{s1}(\lambda)$ varying as a function of light wavelength λ;

a first retarder (63);

a second polarization rotator (64), having its rotation angle $\rho_{s2}(\lambda)$ varying as a function of light wavelength λ;

a second retarder (65);

a third polarization rotator (66), having its rotation angle $\rho_{s3}(\lambda)$ varying as a function of light wavelength λ;

an exit polarizer (67); and

means for rotating said first and second retarders about said beam axis;

and characterized in that said rotation angles $\rho_{s1}(\lambda)$, $\rho_{s2}(\lambda)$ and $\rho_{s3}(\lambda)$ are in the ratios of $\rho_{s1}(\lambda):\rho_{s2}(\lambda):\rho_{s3}(\lambda)=1:-2:1$ over said wavelength range, said first and second retarders (63, 65) are identical, having the retardation Δ equal or approximately equal to a predetermined value, selected preferably between 80° and 115°, over said wavelength range, said entrance and exit polarizers are oriented parallel to each other, having their transmission axes at 45° relative to a selected reference axis, and said first polarization rotator (62), first retarder (63), second polarization rotator (64), second retarder (65) and third polarization rotator (66) are arranged in the recited order between said entrance and exit polarizers (61, 67), with said retarders (63, 65) oriented, having their optic axes symmetric about said reference axis, respectively at angles φ and $-\varphi$ apart from, as viewed along said beam axis. [Ex. FIG. 18]

31. The spectral filter of claim **30** is characterized in that the combination of said rotators (62, 64, 66) and retarders (63, 65) is equivalent to a series connection of two retarder-tuners (68, 69) in accordance with claim **5** having identical retardation Δ and their orientation angles respectively equal to $-(\rho_{s1}(\lambda)+\varphi)$ and $(\rho_{s1}(\lambda)+\varphi)$ relative to said reference axis and said filter has

its spectral transmission determined by said rotation angles, defined by Equation (24), and tunable by simultaneously rotating said retarders (63, 65) in opposite directions about said beam axis with their optic axes keeping symmetric about said reference axis and further tunable by simultaneously varying said rotation angles $\rho_{s1}(\lambda)$, $\rho_{s2}(\lambda)$ and $\rho_{s3}(\lambda)$ with their said ratios of 1:–2:1 remaining unchanged over said wavelength range,

its spectral transmission equivalent to that of a Šolc type two-plate filter when said retarders (63, 65) have their retardation equal or approximately equal to 90° over said wavelength range,

the bandwidth of its transmission peaks adjustable by simultaneously varying said retardation of said retarders preferably in the range from 80° to 115° over said wavelength range, and

its spectral transmission inverted to work as a notch filter that tunably transmits and blocks light at wavelengths where said initial filter blocks and transmits light, respectively, when said exit polarizer (67) is rotated by 90° from said initial orientation to be perpendicular to said entrance polarizer (61). [Ex. FIG. 18]

32. The spectral filter of claim **30** is characterized in that said first, second and third polarization rotators (62, 64, 66) preferably are dispersive optical rotators with their rotation angles in said ratios of 1:–2:1 over said wavelength range and said retarders (63, 65) preferably are equivalent birefringent retarders or liquid crystal electrically rotatable retarders with their optic axes oriented symmetric about said reference axis, and said filter has its spectral transmission tunable by simultaneously rotating said birefringent retarders or

liquid crystal retarders, mechanically and/or electrically, in opposite directions about said beam axis with their optic axes keeping symmetric about said reference axis or such that said birefringent retarders or liquid crystal retarders are parallel to said entrance polarizer (61). [Ex. FIG. 18]

33. The spectral filter of claim **30** is characterized in that said first, second and third polarization rotators (62, 64, 66) preferably are dispersive Faraday rotators, to which magnetic fields are respectively applied, having their rotation angles in said ratios of 1:–2:1 over said wavelength range and said retarders (63, 65) preferably are equivalent birefringent retarders with their optic axes oriented symmetric about said reference axis, respectively at angles φ and $-\varphi$ apart from, as viewed along said beam axis, and said filter further comprises means for varying said Faraday rotation angles by adjusting the magnetic flux densities of said magnetic fields.

34. The spectral filter of claim **33** is characterized in that said filter has its spectral transmission tunable or switchable by simultaneously varying said Faraday rotation angles or switching said Faraday rotation angles in at least two alternative states with said ratios of 1:–2:1 of said Faraday rotation angles remaining unchanged over said wavelength range and functions as a one-direction device that transmits and tunably filters light in one direction, but blocks the backward light, with said birefringent retarders having their retardation preferably equal or approximately equal to 99.8° over said wavelength range and oriented with their optic axes preferably at φ=22.5° and $-\varphi$=–22.5° relative to said reference axis, respectively. [Ex. FIG. 18]

35. The spectral filter of claim **30** is characterized in that said first, second and third polarization rotators (62, 64, 66) preferably are equivalent dispersive optical rotators and said retarders (63, 65) preferably are variable retarders oriented with their optic axes symmetric about said reference axis, each having its retardation variable preferably in the range from 80° to 115° and/or switchable in at least two alternative states such that said variable retarders have their retardation equal or approximately equal to 0° in one of said switched states and equal or approximately equal to value(s), selected preferably between 80° and 115°, in the other state(s) over said wavelength range. [Ex. FIG. 18]

36. The spectral filter of claim **35** is characterized in that said filter has the bandwidth of its spectral transmission peaks adjustable by simultaneously varying said retardation of said variable retarders (63, 65), and its spectral transmission tunable by simultaneously rotating said variable retarders in opposite directions with their optic axes keeping symmetric about said reference axis and switchable by simultaneously switching said variable retarders (63, 65) with their said retardation switched in said states. [Ex. FIG. 18]

37. The spectral filter of claim **6** is characterized in that said filter is a three-tuner spectral filter without intermediate polarizer according to claims **3** and **5** over said wavelength range comprising elements arranged in cascade along said light beam axis including

an entrance polarizer (71);

a first polarization rotator (72), having its rotation angle $\rho_{11}(\lambda)$ varying as a function of light wavelength

λ;

a first quarter-wave retarder (73);

a second polarization rotator (74), having its rotation angle $\rho_{l2}(\lambda)$ varying as a function of light wavelength λ;

a second quarter-wave retarder (75);

a third polarization rotator (76), having its rotation angle $\rho_{l3}(\lambda)$ varying as a function of light wavelength λ;

an exit polarizer (77); and

means for rotating said retarders and said exit polarizer about said light beam axis;

and characterized in that said rotation angles $\rho_{l1}(\lambda)$, $\rho_{l2}(\lambda)$ and $\rho_{l3}(\lambda)$ are in the ratios of $\rho_{l1}(\lambda):\rho_{l2}(\lambda):\rho_{l3}(\lambda)=1:1:-1$ over said wavelength range, said first and second quarter-wave retarders (73, 75) preferably are achromatic or zero-order retarders, having the retardation equal or approximately equal to 90° over said wavelength range, and said first polarization rotator (72), first quarter-wave retarder (73), second polarization rotator (74), second quarter-wave retarder (75) and third polarization rotator (76) are arranged in the recited order between said entrance and exit polarizers (71, 77), with said first and second quarter-wave retarders (73, 75) and said exit polarizer (77) oriented such that the orientation angles φ_1 and φ_2 of said first and second retarders (73, 75) and the azimuth P_2 of said exit polarizer (77), relative to said entrance polarizer (71), are in the ratios of $\varphi_1:\varphi_2:P_2=1:2:1$ or $\varphi_1:(\varphi_2-90°):(P_2-90°)=1:2:1$. [Ex. FIGS. 22, 24]

38. The spectral filter of claim **37** is characterized in that the combination of said rotators (72, 74, 76), retarders (73, 75) and exit polarizer (77) is equivalent to a series connection of two retarder-tuners (78, 79) in accordance with claim **5** and a polarizer-tuner (80) according to claim **3** with said retarder-tuners having identical retardation equal or approximately equal to 90° and their orientation angles respectively equal to $-(\rho_{l1}(\lambda)+\varphi_1)$ and $(2\rho_{l1}(\lambda)+\varphi_2)$, and said polarizer-tuner having its azimuth equal to $\rho_{l1}(\lambda)+P_2$, and said filter has

its spectral transmission determined by said rotation angles, equivalent to that of a Lyot two-stage filter, and tunable by simultaneously rotating said first and second quarter-wave retarders (73, 75) and exit polarizer (77) about said light beam axis with said ratios of $\varphi_1:\varphi_2:P_2=1:2:1$ or $\varphi_1:(\varphi_2-90°):(P_2-90°)=1:2:1$ remaining unchanged or such that said first and second quarter-wave retarders (73, 75) and exit polarizer (77) are parallel or perpendicular to said entrance polarizer, and

its spectral transmission inverted to work as a notch filter that tunably transmits and blocks light at wavelengths where said initial filter blocks and transmits light, respectively, when said exit polarizer (77) is rotated by 90° from its original orientation $P_2=\varphi_1$ or $P_2=90°+\varphi_1$ such that relative to said entrance polarizer (71) the orientation angles of said first and second retarders (73, 75) and the azimuth of said exit polarizer

(77) are in the ratios of $\varphi_1:\varphi_2:(P_2+90°)=1:2:1$ or $\varphi_1:(\varphi_2-90°):P_2=1:2:1$. [Ex. FIG. 22]

39. The spectral filter of claim **37** is characterized in that said first, second and third polarization rotators (72, 74, 76) preferably are dispersive optical rotators with their rotation angles in said ratios of 1:1:–1 over said wavelength range, and said first and second quarter-wave retarders (73, 75) preferably are equivalent birefringent retarders, oriented with their orientation angles and the azimuth of said exit polarizer (77), relative to said entrance polarizer (71), in said ratios of $\varphi_1:\varphi_2:P_2=1:2:1$ or $\varphi_1:(\varphi_2-90°):(P_2-90°)=1:2:1$, and said filter has its spectral transmission tunable by simultaneously rotating said birefringent retarders (73, 75) and exit polarizer (77) about said light beam axis with the said ratios of $\varphi_1:\varphi_2:P_2=1:2:1$ or $\varphi_1:(\varphi_2-90°):(P_2-90°)=1:2:1$ of their said orientation angles and azimuth remaining unchanged. [Ex. FIG. 22]

40. The spectral filter of claim **37** is characterized in that said first, second and third polarization rotators (72, 74, 76) preferably are dispersive Faraday rotators with their rotation angles in said ratios of 1:1:–1 over said wavelength range, to which magnetic fields are applied, respectively, and said first and second quarter-wave retarders (73, 75) preferably are equivalent birefringent retarders, oriented with their orientation angles and the azimuth of said exit polarizer (77), relative to said entrance polarizer (71), in said ratios of $\varphi_1:\varphi_2:P_2=1:2:1$ or $\varphi_1:(\varphi_2-90°):(P_2-90°)=1:2:1$ and said filter further comprises means for electrically changing said Faraday rotation angles by adjusting the magnetic flux densities of said magnetic fields. [Ex. FIG. 22]

41. The spectral filter of claim **37** is characterized in that said filter has its spectral transmission tunable by simultaneously changing said Faraday rotation angles with their said ratios of 1:1:–1 remaining unchanged and further tunable by simultaneously rotating said first and second birefringent retarders (73, 75) and exit polarizer (77) about said light beam axis with said ratios of $\varphi_1:\varphi_2:P_2=1:2:1$ or $\varphi_1:(\varphi_2-90°):(P_2-90°)=1:2:1$ of their said orientation angles and azimuth remaining unchanged or such that said birefringent retarders (73, 75) and exit polarizer (77) are parallel or perpendicular to said entrance polarizer (71) and functions as a one-direction device that transmits and tunably filters light in one direction, but blocks the backward light, with said birefringent retarders (73, 75) and said exit polarizer (77) stationary and oriented relative to said entrance polarizer (71) preferably at $\varphi_1=45°$, $\varphi_2=90°$ and $P_2=45°$ or $\varphi_1=45°$, $\varphi_2=0°$ and $P_2=-45°$, respectively. [Ex. FIG. 22]

42. The spectral filter of claim **37** is characterized in that said first, second and third polarization rotators (72, 74, 76) are dispersive optical rotators with their rotation angles in said ratios of 1:1:–1 over said wavelength range and said exit polarizer (77) preferably is stationary and oriented parallel or perpendicular to said entrance polarizer, and said filter further comprises a rotatable half-wave retarder (81), having its retardation equal or approximately equal to 180° over said wavelength range, positioned between said third polarization rotator (76) and said exit polarizer (77) and oriented at angle φ_3 relative to said entrance polarizer (71) such that said first and second quarter-wave retarders (73, 75) and said half-wave retarder (81) are parallel or perpendicular to said entrance polarizer or have their orientation angles φ_1, φ_2 and φ_3 in the ratios

of $\varphi_1:\varphi_2:\varphi_3=2:4:1$ or $\varphi_1:(\varphi_2-90°):(\varphi_3-90°)=2:4:1$. [Ex. FIG. 24]

43. The spectral filter of claim **42** is characterized in that said filter has its spectral transmission equivalent to that of a Lyot two-stage filter and tunable by simultaneously rotating said quarter-wave retarders (73, 75) and said half-wave retarder (81) about said light beam axis with said ratios of $\varphi_1:\varphi_2:\varphi_3=2:4:1$ or $\varphi_1:(\varphi_2-90°):(\varphi_3-90°)=2:4:1$ of their said orientation angles remaining unchanged or such that said quarter-wave retarders (73, 75) and said half-wave retarder (81) are parallel or perpendicular to said entrance polarizer (71), and said quarter-wave retarders (73, 75) and said half-wave retarder (81) preferably are equivalent achromatic and zero-order birefringent retarders or liquid crystal electrically rotatable retarders. [Ex. FIG. 24]

44. The spectral filter of claim **6** is characterized in that said filter is a three-tuner spectral filter without intermediate polarizer according to claim **5** over said wavelength range comprising elements arranged in cascade along said light beam axis including

an entrance polarizer (82);

a first polarization rotator (83), having its rotation angle $\rho_{p1}(\lambda)$ varying as a function of light wavelength λ;

a first retarder (84);

a second polarization rotator (85), having its rotation angle $\rho_{p2}(\lambda)$ varying as a function of light wavelength λ;

a second retarder (86);

a third polarization rotator (87), having its rotation angle $\rho_{p3}(\lambda)$ varying as a function of light wavelength λ;

a third retarder (88);

a fourth polarization rotator (89), having its rotation angle $\rho_{p4}(\lambda)$ varying as a function of light wavelength λ;

an exit polarizer (90); and

means for rotating said first, second and third retarders about said beam axis;

and characterized in that said rotation angles $\rho_{p1}(\lambda)$, $\rho_{p2}(\lambda)$, $\rho_{p3}(\lambda)$ and $\rho_{p4}(\lambda)$ are in the ratios of $\rho_{p1}(\lambda):\rho_{p2}(\lambda):\rho_{p3}(\lambda):\rho_{p4}(\lambda)=1:-2:2:-1$ over said wavelength range, said first and third retarders (84, 88) are identical, having the retardation Δ equal or approximately equal to a predetermined value selected preferably between 60° and 100° over said wavelength range, said second retarder (86) is a half-wave retarder, having its retardation equal or approximately equal to 180° over said wavelength range, and said first polarization

rotator (83), first retarder (84), second polarization rotator (85), second retarder (86), third polarization rotator (87), third retarder (88) and fourth polarization rotator (89) are arranged in the recited order between said entrance and exit polarizers (82, 90) and oriented such that said entrance polarizer (82) is parallel or at 45° relative to a selected reference axis, said exit polarizer (90) is perpendicular to said entrance polarizer (82), and said first and third retarders (84, 88) are parallel to each other and their optic axes and the optic axis of said second retarder (86) are at the opposite side of said reference axis, respectively at angles $-\varphi$ and $\varphi+45°$ apart from, as viewed along said beam axis. [Ex. FIG. 25]

45. The spectral filter of claim **44** is characterized in that the combination of said rotators (83, 85, 87, 89) and retarders (84, 86, 88) is equivalent to a series connection of three retarder-tuners (91, 92, 93) in accordance with claim **5** with the first and third ones (91, 93) having identical retardation equal to Δ and parallel oriented at angle of $-(\rho_{p1}(\lambda)+\varphi)$, and the central one (92) having the retardation equal or approximately equal to 180° and orientation angle $\rho_{p1}(\lambda)+\varphi+45°$ and said filter has

its spectral transmission determined by said rotation angles and defined by Equation (31A) or (31b) and tunable by simultaneously rotating said first, second and third retarders (84, 86, 88) about said beam axis in the same speed with said first and third retarders (84, 88) synchronously in one direction and said second retarder (86) in the opposite direction to change said angle φ, and further tunable by simultaneously varying said rotation angles $\rho_{p1}(\lambda)$, $\rho_{p2}(\lambda)$, $\rho_{p3}(\lambda)$ and $\rho_{p4}(\lambda)$ with their said ratios of 1:–2:2:–1 remaining unchanged over said wavelength range,

its spectral transmission equivalent to that of a Šolc type three-plate filter or a Lyot two-stage filter when said predetermined value for the retardation of said first and third retarders (84, 88) is 75.52° or 90°,

the bandwidth of its spectral transmission peaks adjustable by simultaneously varying said retardation of said first and third retarders (84, 88) preferably in the range from 60° to 100° over said wavelength range, and

its spectral transmission inverted to work as a notch filter that tunably transmits and blocks light at wavelengths where said initial filter blocks and transmits light, respectively, when said exit polarizer (90) is rotated by 90° from said initial orientation to be parallel to said entrance polarizer (82). [Ex. FIG. 25]

46. The spectral filter of claim **44** is characterized in that said first, second, third and fourth polarization rotators (83, 85, 87, 89) preferably are dispersive optical rotators with their rotation angles in said ratios of 1:–2:2:–1 over said wavelength range and said first, second and third retarders (84, 86, 88) preferably are equivalent birefringent retarders or liquid crystal electrically rotatable retarders with their optic axes oriented relative to said reference axis at $-\varphi$, $\varphi+45°$ and $-\varphi$, respectively, and said filter has its spectral transmission tunable by simultaneously rotating said birefringent retarders or liquid crystal retarders, mechanically and/or electrically, about said beam axis to change said angle φ with the relationship of their orientation angles $-\varphi$, $\varphi+45°$ and $-\varphi$ remaining unchanged. [Ex. FIG. 25]

47. The spectral filter of claim **44** is characterized in that said first, second, third and fourth

polarization rotators (83, 85, 87, 89) preferably are dispersive Faraday rotators, to which magnetic fields are respectively applied, having their rotation angles in said ratios of 1:–2:2:–1 over said wavelength range, and said first, second and third retarders (84, 86, 88) preferably are equivalent birefringent retarders with their optic axes oriented relative to said reference axis at $-\varphi$, φ+45° and $-\varphi$, respectively, and said filter further comprises means for varying said Faraday rotation angles by adjusting the magnetic flux densities of said magnetic fields. [Ex. FIG. 25]

48. The spectral filter of claim **47** is characterized in that said filter has its spectral transmission tunable or switchable by simultaneously varying said Faraday rotation angles or switching said Faraday rotation angles in at least two alternative states with said ratios of 1:–2:2:–1 of said Faraday rotation angles remaining unchanged and functions as a one-direction device that transmits and tunably filters light in one direction, but blocks the backward light, with said birefringent retarders stationary and oriented relative to said reference axis such that their optic axes preferably are at $-\varphi$=–22.5°, φ+45°=67.5° and $-\varphi$=–22.5°, respectively, and said birefringent retarders at $-\varphi$=–22.5° having their retardation Δ preferably equal or approximately equal to 70.5° over said wavelength range. [Ex. FIG. 25]

49. The spectral filter of claim **44** is characterized in that said first, second, third and fourth polarization rotators (83, 85, 87, 89) preferably are equivalent dispersive optical rotators and said first and third retarders (84, 88) preferably are variable retarders with their optic axes oriented parallel at $-\varphi$ relative to said reference axis, each having the retardation Δ variable preferably in the range from 60° to 100° and said third retarder (86) preferably is a birefringent half-wave retarder oriented at φ+45° relative to said reference axis, and said filter has the bandwidth of its spectral transmission peaks adjustable by simultaneously varying said retardation Δ of variable retarders and its spectral transmission tunable by simultaneously rotating said variable retarders and said half-wave retarder in the same speed with said variable retarders synchronously in one direction and said half-wave retarder in the opposite direction to change said angle φ. [Ex. FIG. 25]

50. The spectral filter of claim **44** is characterized in that said first, second, third and fourth polarization rotators (83, 85, 87, 89) preferably are equivalent dispersive optical rotators and said first, second and third retarders (84, 86, 88) preferably are variable retarders oriented relative to said reference axis with their optic axes at $-\varphi$, φ+45° and $-\varphi$, respectively, which are operated to have their the retardation switchable in at least two alternative states such that in one of said switched states said variable retarders have their retardation equal or approximately equal to 0° and in the other state(s) said variable retarders at $-\varphi$ have their retardation valued preferably in the range from 60° to 100°, and said variable retarder at φ+45° has its retardation equal or approximately equal to 180° over said wavelength range.

51. The spectral filter of claim **50** is characterized in that said filter has its spectral transmission switchable by simultaneously switching said variable retarders with their said retardation switched in said switched states, the bandwidth of its spectral transmission peaks adjustable by simultaneously varying said retardation of said variable retarders at $-\varphi$ with said variable retarder at φ+45° operated to have the retardation equal or approximately equal to 180° over said wavelength range, and its spectral transmission tunable by simultaneously rotating said variable retarders about said beam axis in the same speed with said

variable retarders at $-\varphi$ synchronously in one direction and said variable retarder at $\varphi+45°$ in the opposite direction to change the angle φ. [Ex. FIG. 25]

52. The spectral filter of claim **6** is characterized in that said filter is a three-tuner spectral filter without intermediate polarizer according to claim **5** over said wavelength range comprising elements arranged in cascade along said light beam axis including

an entrance polarizer (94);

a first polarization rotator (95), having its rotation angle $\rho_{b1}(\lambda)$ varying as a function of light wavelength λ;

a first retarder (96);

a second polarization rotator (97), having its rotation angle $\rho_{b2}(\lambda)$ varying as a function of light wavelength λ;

a second retarder (98);

a third polarization rotator (99), having its rotation angle $\rho_{b3}(\lambda)$ varying as a function of light wavelength λ;

a third retarder (100);

a fourth polarization rotator (101), having its rotation angle $\rho_{b4}(\lambda)$ varying as a function of light wavelength λ;

an exit polarizer (102); and

means for rotating said retarders (96, 98, 100) about said beam axis;

and characterized in that said rotation angles $\rho_{b1}(\lambda)$, $\rho_{b2}(\lambda)$, $\rho_{b3}(\lambda)$ and $\rho_{b4}(\lambda)$ are in the ratios of $\rho_{b1}(\lambda):\rho_{b2}(\lambda):\rho_{b3}(\lambda):\rho_{b4}(\lambda) = 3:-4:4:-3$ over said wavelength range, said first, second and third retarders (96, 98, 100) have their retardation Δ_1, Δ_2 and Δ_3 valued such that the conditions $30° \leq \Delta_1 = \Delta_3 \leq 50°$ and $170° \leq 2\Delta_1 + \Delta_2 \leq 220°$ are preferably satisfied over said wavelength range, and said first polarization rotator (95), first retarder (96), second polarization rotator (97), second retarder (98), third polarization rotator (99), third retarder (100) and fourth polarization rotator (101) are arranged in the recited order between said entrance and exit polarizers (94, 102) and oriented such that said entrance and exit polarizers (94, 102) are perpendicular to each other and the orientation angles of said first, second and third retarders (96, 98, 100) relative to said entrance polarizer (94) are 3φ, $-\varphi$, and 3φ , respectively, and in the ratios of $3\varphi:-\varphi:3\varphi = 3:-1:3$. [Ex. FIG. 29]

53. The spectral filter of claim **52** is characterized in that the combination of said polarization rotators (95, 97, 99, 101) and retarders (96, 98, 100) is equivalent to a series connection of three retarder-tuners

(103, 104, 105) in accordance with claim **5** with the first and third ones (103, 105) having identical retardation equal to Δ_1 and parallel oriented at angle of $3(\rho_{b1}(\lambda)+\varphi)$ and the central one (104) having the retardation equal to Δ_2 and orientation angle $-(\rho_{b1}(\lambda)+\varphi)$ and said filter has

its spectral transmission determined by said rotation angles and defined by Equation (36a) or (36b) and tunable by simultaneously rotating said first, second and third retarders (96, 98, 100) about said beam axis with said first and third retarders (96, 100) synchronously in one direction and said second retarder (98) in the opposite direction to change their said orientation angles with said ratios of 3:–1:3 remaining unchanged or such that said first, second and third retarders (96, 98, 100) are parallel to said entrance polarizer, and further tunable by simultaneously varying said rotation angles $\rho_{b1}(\lambda)$, $\rho_{b2}(\lambda)$, $\rho_{b3}(\lambda)$ and $\rho_{b4}(\lambda)$ with said their ratios of 3:–4:4:–3 remaining unchanged over said wavelength range,

its spectral transmission of square-waveform or approximate square-waveform with said retardation Δ_1, Δ_2 and Δ_3 preferably valued such that $30°\leq\Delta_1=\Delta_3\leq50°$ and $170°\leq2\Delta_1+\Delta_2\leq220°$,

the slope of its maximum transmission peaks and the secondary maximum adjustable by simultaneously varying said retardation Δ_1, Δ_2 and Δ_3, with the conditions $30°\leq\Delta_1=\Delta_3\leq50°$ and $170°\leq2\Delta_1+\Delta_2\leq220°$ preferably maintained, and

its spectral transmission inverted to work as a notch filter that tunably transmits and blocks light at wavelengths where said initial filter blocks and transmits light, respectively, when said exit polarizer (102) is rotated by 90° from said initial orientation to be parallel to said entrance polarizer (94). [Ex. FIG. 29]

54. The spectral filter of claim **52** is characterized in that said first, second, third and fourth polarization rotators (95, 97, 99, 101) preferably are dispersive optical rotators with their rotation angles in said ratios of 3:–4:4:–3 over said wavelength range and said first, second and third retarders (96, 98, 100) preferably are equivalent birefringent retarders or liquid crystal electrically rotatable retarders, oriented such that their orientation angles relative to said entrance polarizer are in said ratios of 3:–1:3, and said filter is tunable by simultaneously rotating said birefringent retarders or liquid crystal retarders, mechanically and/or electrically, about said beam axis, with said ratios of 3:–1:3 of their said orientation angles remaining unchanged or such that said birefringent retarders or liquid crystal retarders are parallel to said entrance polarizer (94). [Ex. FIG. 29]

55. The spectral filter of claim **52** is characterized in that said first, second, third and fourth polarization rotators (95, 97, 99, 101) preferably are dispersive Faraday rotators, to which magnetic fields are respectively applied, having their rotation angles in said ratios of 3:–4:4:–3 over said wavelength range and said first, second and third retarders (96, 98, 100) preferably are equivalent birefringent retarders with their optic axes oriented such that their orientation angles relative to said entrance polarizer (94) are in said ratios of 3:–1:3, and said filter further comprises means for varying said Faraday rotation angles by adjusting the magnetic flux densities of said magnetic field. [Ex. FIG. 29]

56. The spectral filter of claim **55** is characterized in that said filter has its spectral transmission tunable or switchable by simultaneously varying said Faraday rotation angles or switching said Faraday rotation angles in at least two alternative states with said ratios of 3:–4:4:–3 of said Faraday rotation angles remaining unchanged over said wavelength range, and functions as a one-direction device that transmits and tunably filters light in one direction, but blocks the backward light, with said birefringent retarders stationary and oriented relative to said entrance polarizer (94) such that their optic axes preferably are at $3\varphi=67.5°$, $-\varphi=-22.5°$ and $3\varphi=67.5°$, respectively, and said retardation Δ_1 and Δ_3 preferably equal or approximately equal to 38.4° and said retardation Δ_2 equal or approximately equal to 108.2° over said wavelength range. [Ex. FIG. 29]

57. The spectral filter of claim **52** is characterized in that said first, second, third and fourth polarization rotators (95, 97, 99, 101) preferably are equivalent dispersive optical rotators and said first, second and third retarders (96, 98, 100) preferably are variable retarders, which are oriented relative to said entrance polarizer with the orientation angles of their optic axes in said ratios of 3:–1:3 and operated to have their the retardation switchable in at least two alternative states such that in one of said switched states said variable retarders have their retardation equal or approximately equal to 0° and in the other state(s) the variable retarders have their retardation valued to satisfy said conditions for the retardation over said wavelength range. [Ex. FIG. 29]

58. The spectral filter of claim **57** is characterized in that said filter has its spectral transmission switchable by simultaneously switching said variable retarders with their said retardation switched in said switched states, the slope of its maximum transmission peaks and the secondary maximum adjustable by simultaneously varying said retardation of said variable retarders with said conditions remaining satisfied, and its spectral transmission tunable by simultaneously rotating said variable retarders about said beam axis with said ratios of 3:–1:3 of their orientation angles remaining unchanged. [Ex. FIG. 29]

59. A method for wavelength-tunably filtering light over a wavelength range, comprising the steps of:

providing a spectral filter according to claim **6**, the spectral filter comprising an entrance polarizer, at least a dispersive polarization rotator and at least an orientation-sensitive polarizing element; and

tuning said spectral filter by rotating said polarizing element(s) and/or by varying the rotation angle(s) of said polarization rotator(s). [Ex. FIGS. 7-11, 14, 16-18, 22, 24, 25, 29]

60. The method of claim **59** is characterized in that said filter is a single-stage spectral filter according to claim **8**, comprising an entrance polarizer, a rotatable exit polarizer, and a dispersive polarization rotator, and said method comprises the step of tuning said single-stage filter by rotating said exit polarizer relative to said entrance polarizer and/or by varying the rotation angle of said dispersive polarization rotator. [Ex. FIGS. 7, 8-10]

61. The method of claim **60** is characterized in that said single-stage filter is modified according to

claim **12** or claim **14** to further comprise a rotatable half-wave retarder or an active polarization rotator, and said method further comprises the step of tuning said filter by rotating said retarder or varying the rotation angle of said active polarization rotator. [Ex. FIGS. 8, 9]

62. The method of claim **60** is characterized in that said single-stage filter is modified according to claim **17** to further comprise a second dispersive polarization rotator and a variable retarder having its retardation switchable between two alternative states; and said method further comprises the step of tuning said filter by switching said retarder in said switched states. [Ex. FIG. 10]

63. The method of claim **59** is characterized in that said filter is an n-stage (n=2, 3, 4, ...) spectral filter according to claim **19**, the n-stage spectral filter comprising an entrance polarizer, n rotatable polarizers, and n dispersive polarization rotators with said entrance polarizer, n rotatable polarizers and n polarization rotators arranged and said n rotatable polarizers oriented in accordance with claim **19**, and said method comprises of the step of tuning said n-stage filter by simultaneously rotating said n rotatable polarizers with the ratios of their azimuths remaining unchanged or such that said n rotatable polarizers are parallel or perpendicular to said entrance polarizer and further by simultaneously varying said rotation angles of said n polarization rotators with the ratios of their said rotation angles remaining unchanged. [Ex. FIGS. 11, 14, 16, 17]

64. The method of claim **63** is characterized in that said n-stage filter is modified according to claim **23** or claim **25** to further comprise n rotatable half-wave retarders or n active polarization rotators, and said method further comprises the step tuning said n-stage filter by simultaneously rotating said n half-wave retarders with the ratios of their orientation angles remaining unchanged or such that said orientation angles are equal to zero or by simultaneously varying the rotation angles of said n active polarization rotators with their ratios remaining unchanged or equal or approximately equal to zero over said wavelength range. [Ex. FIGS. 14, 16]

65. The method of claim **63** is characterized in that said n-stage filter is modified according to claim **22** to further comprise another n dispersive polarization rotators and n identical variable retarders, each having its retardation switchable between two alternative states, and said method further comprises the step of tuning said filter by simultaneously switching said n variable retarders in said switched states and/or by simultaneously rotating said n retarders with the ratios of their said orientation angles remaining unchanged or such that each of said n retarders is parallel to its immediately preceding polarizer. [Ex. FIG. 17]

66. The method of claim **59** is characterized in that said filter is a spectral filter without intermediate polarizer according to claim **30**, claim **37**, claim **44**, or claim **52**, the spectral filter without intermediate polarizer comprising an entrance polarizer, an exit polarizer, at least three dispersive polarization rotators and at least two retarders with said retarders oriented in accordance with claim **30**, claim **37**, claim **44**, or claim **52**, and said method comprises of the step of tuning said filter by simultaneously rotating said retarders [Ex. FIGS. 18, 24, 25, 29] or said retarders and exit polarizer [Ex. FIG. 22] with the ratios of their orientation

angles remaining unchanged and/or by simultaneously varying the rotation angles of said polarization rotators with the ratios of said rotation angles remaining unchanged over said wavelength range and/or adjusting the transmission profile of said filter by varying the retardation of said retarders preferably in a predetermined range [Ex. FIGS. 18, 25, 29]. [Ex. FIGS. 18, 22, 24, 25, 29]